USSR Report

PHYSICS AND MATHEMATICS

No. 65

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EXCITATION AND AMPLIFICATION OF ELASTIC WAVES IN LEAD MOLYBDATE CRYSTALS
UNDER THE ACTION OF POWERFUL LASER RADIATION

D'YAKONOV, A. M., LEMANOV, V. V. and SATTIKULOV, M., Leningrad, Physico-
Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] Considering that the generation and amplification of ultrasound
in crystals in the presence of powerful laser radiation is of major interest
to research into the processes of nonlinear acoustooptical interaction
as well as in itself as a method for generating intense elastic waves in
the microwave range, corresponding experiments were performed on crystals
of lead molybdate $PbMoO_4$, which is known for its high acousto-optical
effectiveness. A Q-switched single-mode ruby laser ($\lambda_0 = 0.694$ μm)
was used as the source of radiation. The pulse duration was 40 ns and
the pulse power, $\sim$6 MW. The excitation of hypersonic waves was inves-
tigated by mixing two laser beams with different frequencies in the inves-
tigated specimens of lead molybdate. The amplification of ultrasonic
waves introduced into the crystals upon diffracting laser radiation on
these waves was also investigated. It is shown that the power of the
excited ultrasound is proportional to the product of the laser beam inten-
sities as well as to the square of the frequency of the ultrasonic waves.
The power of the elastic waves under the specified conditions was 10^{-4} W/cm^2.
The experimental findings are in agreement with theory. Figures 8;
references 11: 4 Russian, 7 Western.
[148-1386]

DEEP-LYING FREE AND BOUND EXCITONS AND BIEXCITONS IN GaSe, AND THEIR
COLLECTIVE INTERACTION

SOLOMONOV, Yu. F. and SUBASHIYEV, V. K., Physicotechnical Institute imeni
A. F. Ioffe, USSR Academy of Sciences

[Abstract] In previous research, deep excitons have been observed in the
absorption spectra of GaSe. These are exciton states associated with
the extrema of bands deeper than those responsible for the fundamental
absorption edge. In this paper the authors investigate the photolumines-
cence spectra of GaSe in this same region of the spectrum at 4.2 and 77 K
stimulated by the second harmonic of a ruby laser with maximum emission
intensity of $2 \cdot 10^{24}$ phot$\cdot cm^{-2}$ s^{-1} (1 MW/cm^2) in a pulse of 40 ns duration.
The experimental data are analyzed on the basis of notions of the interaction
between deep-lying excitons at high concentration like those used for

edge excitons. The pumping dependence of line intensity is studied
separately for eight different lines. The results show that deep excitons
are bound into a molecule, that these formations interact with each other
and with carriers, and also with deep-lying exciton-impurity complexes.
The parameters of states and processes are determined. Figures 2,
references 8: 3 Russian, 5 Western.
[154-6610]

CONCERNING THE POSSIBILITIES THAT A METAL-DIELECTRIC FRONT WILL REACH
RELATIVISTIC VELOCITIES WHEN A FILM IS VAPORIZED BY INTENSE LIGHT

ASKAR'YAN, G. A. and MANZON, B. M., Physics Institute imeni P. N. Lebedev,
USSR Academy of Sciences

[Abstract] An analysis is made of radiant vaporization of a metallized
film a few hundred angstroms thick on the surface of a polymer sheet when
subjected to an intense light beam incident normally to the sheet. It
is theoretically shown that under certain conditions the vaporization front
can reach relativistic (and even faster-than-light) velocities. Pre-
liminary experiments on attainment of high velocities are described, and
it is shown that even in these experiments velocities of $4 \cdot 10^9$ cm/s
were reached. Such moving metal-dielectric fronts could be used for
observing Doppler shifts and frequency broadening of light and radio waves,
for observing Cherenkov effects from polarization or currents in the film,
and also for particle acceleration. Figures 3, references 5 Russian.
[154-6610]

GIANT OPTICAL NONLINEARITY IN THE MESOPHASE OF A NEMATIC LIQUID CRYSTAL

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of Sciences, PILIPETSKIY, N. F., SUKHOV, A. V., Institute of Problems
of Mechanics, USSR Academy of Sciences, and TABIRYAN, N. V., Department
of Optics, Yerevan State University

[Abstract] It is theoretically shown that rotation of the director of
a nematic liquid crystal by the field of a light wave should lead to self
focusing, resulting in giant optical nonlinearity in the oriented mesophase
of the crystal. In experiments, the emission from a helium-neon laser
radiating in the lower transverse mode was passed through light filters

and focused by a lens on the nematic liquid crystal enclosed in a glass
cell. The angular divergence of the transmitted beam in the far zone was
photographed by a camera with a light filter system and without an objec-
tive lens. It is shown that laser emission with power of about 10^{-2} W
and power density of about 50 W/cm^2 undergoes self-focusing in a liquid
crystal layer 60 μm thick with planar orientation and oblique incidence
of an extraordinary wave. The measured effective constant of nonlinearity
corresponds to a value 10^9 times that of hydrogen sulfide. Figures 3,
references 7: 6 Russian, 1 Western.
[154-6610]

STARK-CYCLOTRON RESONANCE IN SEMICONDUCTORS WITH A SUPERLATTICE

BASS, F. G., ZORCHENKO, V. V. and SHASHORA, V. I., Khar'kov Polytechnical
Institute imeni V. I. Lenin

[Abstract] Considerable research has been done on cyclotron resonance
in ordinary semiconductors, and on Stark resonance in semiconductors
with a superlattice. If dispersion is an appreciably periodic function
of quasi-momentum, an electron will undergo finite periodic motion in
a fixed electric field with Stark frequency, and in a constant magnetic
field with Larmor frequency. It can be expected that when the Stark and
cyclotron frequencies coincide, the fixed current will behave resonantly.
The authors call such resonance Stark-cyclotron resonance. It should
arise on multiples of Larmor and Stark frequencies, since the law of
electron dispersion is non-quadratic. It is shown that the current
changes sign, and in the vicinity of resonance negative absolute conduc-
tivity is observed with possible instability of the electric current.
Conditions of Stark-cyclotron resonance are determined for a constant
electric field, and also for an electric field that has a component
that varies periodically. The authors thank I. B. Levinson for construc-
tive criticism. References 3 Russian.
[156-6610]

OBSERVATION OF QUANTUM STATES OF FAST ELECTRONS IN PLANAR CHANNELING

VOROB'YEV, S. A., KAPLIN, V. V., POPOV, D. YE. and KOSTAREVA, O. G.,
Scientific Research Institute of Nuclear Physics, Tomsk State University
imeni S. M. Kirov

[Abstract] In recent research associated with channeling of fast charged
particles in single crystals, many experiments have failed to show quantum
effects, which can be attributed to the quasi-continuous nature of the
system of levels in the periodic potential of atomic planes. In this
paper, the authors report clear observations of individual quantum states
in planar channeling of fast electrons for certain crystal orientations.
The research is based on measurement of the angular distributions of elec-
trons with energy of 4.9 MeV transmitted through a silicon crystal about
2 μ m thick. Analysis of these distributions shows preferred population
of individual quantum states of the channeled electrons along (110) of the
atomic planes. This effect can be used to control the electron flux in
a crystal, and to realize spontaneous and induced processes in emission
and absorption of energy of an initially free beam. By placing the crystal
in an electric field, it should be possible to observe the relativistic
analog of the Stark effect -- a shift in the maximum of the emission spec-
trum of the channeled particles. Through the Doppler effect, this dis-
placem nt may reach several percent. The authors thank A. S. Tulinov,
V. I. Gol'danskiy, V. G. Baryshevskiy, N. P. Kalashnikov and V. L. Indenbom
for interest in the work. Figures 2, references 4: 3 Russian, 1 Western.
[156-6610]

TUNNEL IMPURITY AUTOLOCALIZATION IN SEMICONDUCTORS. NATURE OF ANOMALOUS PROPERTIES OF INDIUM-DOPED $Pb_{1-x}Sn_xTe$

KAGAN, YU. and KIKOIN, K. A., Institute of Atomic Energy imeni I. V. Kur-
chatov

[Abstract] The $Pb_{1-x}Sn_xTe$(In) system has the following anomalies:
1. indium doping in alloys with $x < 0.2$ results in a level $\varepsilon_0(x)$ in the
conduction band that fixes the energy of the Fermi level ε_F if the indium
concentration exceeds that of other defects; 2. ε_0 decreases linearly
with x, crosses the energy gap and enters the valence band without any
discontinuities at the edges of the conduction and valence bands; 3. if
there is a stepwise change in ε_F, violating the condition $\varepsilon_0 = \varepsilon_F$, the
flow of electrons from the level to the conduction band or vice versa

is anomalously slow, and may last for hours at helium temperatures;
4. these compounds have unique photosensitivity in the dielectric state
at low temperatures -- the resistance drops by many orders of magnitude
under very weak illumination, increases with rising temperature, and
recovers the activation drop in resistance with temperature when temperatures
of the order of 20 K are reached. The authors propose the concept of a
tunnel impurity state of autolocalization nature that explains all these
anomalous properties of the system from a single standpoint. Such states
are due to electron capture by an intrinsic impurity well during defor-
mation, leading to the development of sub-barrier kinetics. The authors
thank N. B. Brandt and B. A. Akimov for discussing the experimental aspects
of the problem, and also E. I. Rashba for discussion. Figures 2,
references 8 Russian.
[156-6610]

CYCLOTRON RESONANCE OF FREE CARRIERS IN NONUNIFORMLY DEFORMED GERMANIUM

MAKAROV, A. G., MANENKOV, A. A., MIKHAYLOV, G. N. and SEFEROV, A. S.,
Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Cyclotron resonance is studied in nonuniformly deformed ger-
manium exposed to pulsed laser pumping in connection with the problem of
large electron-hole drops. The physical properties of such drops have
been well studied, but there has not been much investigation of the
properties of the surrounding cloud of free excitons and free carriers.
Analysis of the cyclotron resonance spectra shows a number of important
characteristics of the cloud of free carriers, their kinetics and spatial
distribution. The experiments were done on specimens of dislocation-free
n-Ge with residual impurity concentration of about $7 \cdot 10^{11}$ cm^{-3} nonuniformly
compressed in direction $\langle 111 \rangle$. Optical stimulation was by a YAG Nd^{3+}
laser ($\lambda = 1.06$ μm). The specimen was placed in a microwave resonator
in the maximum of the electric field with axis $\langle 111 \rangle$ of the crystal
parallel to the magnetic field and perpendicular to the electric field.
The cyclotron resonance spectra were recorded by a microwave spectrometer
($\lambda = 3.2$ cm), the applied pressure was about 1500 kg/cm^2, and drop lifetime
was 500 μs. The results of the study showed nonuniform distribution
of free carriers above the electron-hole drop localized in a potential
well. An analysis of the shape of the cyclotron resonance line at 4.2 K
gave a free carrier concentration of $3.5 \cdot 10^{12}$ cm^{-3} on the surface of the
electron-hole drop. Figure 1, references 11: 5 Russian, 6 Western.
[153-6610]

FORMATION OF MOLECULAR IONS WHEN THE SURFACE OF MOLECULAR CRYSTALS IS
EXPOSED TO ULTRAVIOLET LASER RADIATION

ANTONOV, V. S., LETOKHOV, V. S. and SHIBANOV, A. N., Institute of
Spectroscopy, USSR Academy of Sciences

[Abstract] An investigation is made of the problem of separating molecular
ions directly from the surface of a solid while retaining molecular
individuality. Previously used methods include desorption of simple
neutral molecules under the action of light, and vaporization of a mixture
of atoms, ions and molecules of different kinds by plasma formation when
the surface is heated by laser emission. In this paper the authors
report experimental observation of the removal of molecular ions from
the surface of a molecular crystal by an ultraviolet laser pulse unassociated
with heating. The experiment involved mass spectrometric analysis of
products of photodissociation when the surfaces of molecular crystals of
nucleic acid bases and anthracene are exposed to KrF laser pulses
(λ = 249 nm). A time-of-flight mass spectrometer was used, enabling
investigation of the velocity distribution of the resultant photo-ions
and the delay between laser bombardment and ion departure from the surface.
The authors thank D. N. Nikogosyan for furnishing the experimental materials.
Figures 2, references 4: 3 Russian, 1 Western.
[153-6610]

THERMAL BLOOMING EFFECT IN GAS-DYNAMIC MODES

KOGAN, M.N. and KUCHEROV, A. N.

[Abstract] The thermal blooming effect in an intensive light beam is considered in a transverse stream of a weakly absorbing homogeneous gas subject to density perturbations. The heat conduction mode (including forced convection) and the heat convection mode (forced convection only) can be treated in the isobaric approximation, while the subsonic mode and the transsonic mode as well as the supersonic mode and the hypersonic mode involve pressure perturbations. The viscosity and the thermal conductivity of the gas can be disregarded. The characteristic intensity of the light beam is, for the purpose of comparative evaluation, referred to that of a collimated Gaussian beam in the near field. Somewhere within the subsonic range defocusing changes to self-focusing so that the intensity peak increases instead of decreasing. Within this range as well as in the heat conduction and convection modes the intensity peak shifts toward the stream. within the transsonic range it ceases to shift and with.. the supersonic range it shifts downstream. The article was presented by academician A. A. DORODNITSYN on 2 Oct 79. Figures 1; references 11: 7 Russian, 4 Western.
[147-2415]

INFRARED LASERS AND MOLECULAR TECHNOLOGY

VELIKHOV, Yevgeniy Pavlovich, physicist, academician, vice-president USSR Academy of Sciences, and deputy director Institute of Atomic Energy imeni I. V. Kuratov, and LETOKHOV, Vladilen Stepanovich, physicist, doctor of physico-mathematical sciences, deputy director Institute of Spectroscopy at the USSR Academy of Sciences

[Abstract] Interaction of infrared electromagnetic radiation and molecular or atomic vibrations, which occur within the $1.5 \cdot 10^{14} - 6 \cdot 10^{12}$ Hz frequency range, has some very far-reaching implications. Vibrations of a molecule are characterized by three possible modes of motion associated with corresponding components of its internal energy: vibrations of electrons, vibrations of atoms relative to their equilibrium configuration in the molecule, and rotation of the molecule as a single entity. The degrees of freedom, the number of frequencies and combination frequencies, oscillations of the dipole moment and resulting interaction with an infrared radiation field depend on the complexity and structural summetry of the molecule. There are three possible practical applications for this behavior of molecules. First comes generation of coherent infrared radiation, according to the "golden rule" that only in matter in a state of far nonequilibrium are amplification and emission of coherent radiation possible. Vibrational transitions in a molecule have led to the successive development of high-efficiency high-power continuous and pulse gas lasers (He-Ne, Ar^+, CO_2, CO_2-N_2-He), with atmospheric pressure and with transverse excitation, also gas-dynamic and chemical lasers (D_2-F_2, UF_6, CO_2-N_2-^{3}He). Next come nonequilibrium excitation of molecular vibrations and dissociation of molecules by infrared radiation, including natural photo-chemical processes in the ozone layer of the upper atmosphere and in biomolecules as well as in industrial processes such as selective separation of isotopes and purification of substances. Last comes frequency conversion of infrared radiation, according to the "golden rule" that laser radiation can always be converted to a longer-wave radiation in an appropriate resonantly absorbing medium, by a molecule such as NH_3 absorbing infrared radiation pulses from a pumping laser and, thus excited into a vibrational-rotational state, emitting radiation on the fundamental or harmonic frequency. Tremendous progress has been made since the discovery of infrared radiation in the solar spectrum by William Herschel in 1800 to the powerful infrared molecular lasers built in the nineteen seventies. Figures 3.
[152-2413]

SMOOTH REGULATION OF THE PUMPING ENERGY IN FREQUENCY-CONTROLLED LASERS
WITH AUXILIARY STORAGE DEVICE

BALYAVKO, V. V., KRYLOV, B. V., MOZGO, A. A., Institute of Physics of the
Belorussian SSR Academy of Sciences

[Abstract] Some techniques for accomplishing a different method of smooth
regulation of pumping energy in frequency-controlled lasers are described.
A storage capacitor bank is always charged to the amplitude value of the
voltage at the output of a power rectifier and charging is carried out
without resorting to any current-limiting components. Pumping energy can
be regulated by monitoring the voltage drop across the capacitor bank using
a threshold device whose output signal is fed to the input of a flash lamp
ignition block. Schemes of pumping energy regulation are considered that
are based on varying the duration of preliminary energy transfer to the
auxiliary storage device or on varying the parameters of this storage
device. The effectiveness of the described method of regulation can
be estimated on the basis of the energy balance initially stored in the
capacitor bank, the pumping energy and the energy left in the capacitor
bank after recharging as a result of the oscillatory process with regard
to active losses. Figures 4, references 7 Russian.
[149-6521]

POLARIZATION OF CONTINUOUS X-RADIATION OF A PICOSECOND LASER PLASMA

BLASHENKOV, V. V., ZAKHAROV, S. D., KIRKIN, A. N., KONONOV, A. V.,
KOTENKO, L. P., LEONTOVICH, A. M., MERZON, G. I, and MOZHAROVSKIY, A. M.,
Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] One of the most effective ways to study the mechanism of
formation of superthermal electrons is to measure the polarization of
x-bremsstrahlung, which provides direct information on the presence and
direction of ordered electron fluxes in a plasma. The authors measured
the polarization of superthermal x-radiation (hν of the order of 10 keV
or more) of a plasma set up by a ruby laser at low temperature with self-
mode locking. The laser had an energy of 0.2-0.5 J, pulse duration of
10-30 ps, and flux density on the target of 10^{13}-10^{14} W/cm^2. Polarization
was measured by a Thomson polarimeter consisting of an LiD scatterer
and two pairs of mutually perpendicular scintillation spectrometers based

on NaI(Tl) crystals and an FEU-85 photomultiplier. Another scintillation
spectrometer was placed behind the scatterer to check the energy of the
x-radiation transmitted through the scatterer. Spectrometers on a vacuum
target chamber measured the effective temperature of superthermal electrons
from their bremsstrahlund spectrum by an absorber method. Analysis of
the results shows polarization of the continuous x-radiation of the laser
plasma, indicating a stream of superthermal electrons in the direction
of the plasma density gradient with an effective temperature of 3-8 keV.
The authors thank A. L. Chernyakov and A. N. Chuzo for discussing the
results and assisting with the work. Figure 1, references 12: 7 Russian,
5 Western.
[156-6610]

MODE-LOCKING OF EMISSION IN INDUCED SCATTERING OF THE LIGHT OF THE LIMB
OF THE RAYLEIGH LINE IN AN EXTERNAL RESONATOR

ZASKAL'KO, O. P., MALIKOV, M. R., POSTOVALOV, V. YE., STARUNOV, V. S. and
FABELINSKIY, I. L., Physics Institute imeni P. N. Lebedev, USSR Academy
of Sciences

[Abstract] The authors report the first direct observation of stimulated
emission of a periodic sequence of picosecond pulses of light with forced
scattering of the limb of the Rayleigh line (stimulated Raman scattering)
in hydrogen sulfide in an external transverse optical cavity. Under certain
conditions two regular groups of pulses are observed following with an
interval equal to half of the axial period of the cavity, each of these
pulses in turn being comprised of several pulses with a space of about
160 ps. Conditions are also determined for excitation of an isolated
picosecond pulse of stimulated Raman scattering on the axial period.
The authors thank M. Ya. Shchelev for assistance with the experiments
and discussion of the results. Figure 1, references 7: 6 Russian, 1 Wes-
tern.
[152-6610]

ORIENTATION OF ATOMS IN THE PROCESS OF PHOTODISSOCIATION OF MOLECULES

VASYUTINSKIY, O. S., Physicotechnical Institute imeni A. F. Ioffe,
USSR Academy of Sciences

[Abstract] In the effect of optical orientation of atoms, angular momen-
tum is transferred from light to an assembly of atoms when an atomic sys-
tem interacts with circularly polarized radiation. Electronic angular
momentum may also be transferred from helium atoms to hydrogen atoms formed
by ionization when hydrogen atoms collide with optically oriented helium
atoms. In this paper the author demonstrates a completely different
mechanism for transfer of angular momentum to atoms from light. It is
shown that an oriented assembly of atoms can be produced by the process
of photodissociation of molecules by circularly polarized light. The
angular momentum introduced into the system by the polarized radiation
is transferred to the atoms formed by photodissociation through unstable
excited states of the molecules. An important factor in this process is
the fact that the lifetime of the molecules in the unstable state is
usually much shorter than the time that characterizes the relation between
the electronic momentum of the molecules and their rotation. In experiments,
oriented cesium atoms are produced in photodissociation of CsI molecules
by circularly polarized ultraviolet radiation. The author thanks R. A.
Zhitnikov for interest in the work and discussion of the results, Ye. B.
Aleksandrov for consultation in setting up the experiment, and A. I.
Okunevich for constructive criticism. Figures 2, references 6: 2 Russian,
4 Western.
[153-6610]

EXCITATION OF DRIFT MOTION OF POLYATOMIC MOLECULES BY RESONANT INFRARED
RADIATION

BARANOV, V. YU., VELIKHOV, YE. P., DYKHNE, A. M., KAZAKOV, S. A.,
MEZHEVOV, V. S., ORLOV, M. YU., PIS'MENNYY, V. D., STARODUBTSEV, A. I.
and STAROSTIN, A. N.

[Abstract] Experimental studies were done on drift motion of SF_6 molecules
caused by pulse-periodic action of a CO_2 laser. The molecular gas was
exposed in a mixture with a buffer gas (He or H_2). Pulse duration was
5 μs with variable energy in a pulse (0.1-1 J) and pulse recurrence rate
(up to 200 Hz). Average input power to the gas was about 20 W. The
density of the gas was continuously monitored by an IKS-29 spectrophotometer,

and the IR and mass spectra were measured before and after exposure. It was found that the ratio of concentrations of SF_6 molecules at the inlet and outlet ends of the test cell (1 m long with a cross section of 1 x 3 cm) reached about 100. The corresponding fluxes of resonant molecules are billions of times greater than those obtained in experiments with sodium vapor exposed to optical radiation. The authors thank L. A. Bol'shov, A. P. Napartovich and G. I. Surdutovich for interest in the work and useful discussions, and V. I. Derbilov for assistance with the experiments. Figures 3, references 8: 7 Russian, 1 Western.
[153-6610]

CRITICAL EFFECTS DURING MOTION OF A COLD PLASMA

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Academy of Sciences

[Abstract] Existence and stability conditions of a one-dimensional
steady plasma stream are analyzed, considering that the thermal conduc-
tivity and the viscosity determine all major dissipation processes in such
a medium. The plasma is assumed to be flowing symmetrically between two
parallel plates under a constant pressure gradient, with the temperature
of these plates maintained uniform along the stream. The viscosity and
the thermal conductivity (sum of a molecular component and a reaction
component) respectively decrease and increase with rising temperature,
within the range of intensive dissociation and ionization. The two
partial differential equations of motion and energy in rectangular co-
ordinates are reduced to a single second-order differential equation in
polar coordinates with two dimensionless parameters, the algebraic sign
of one determining whether or not there is a critical value of the other
above which the flow becomes discontinuous for given boundary conditions.
This general analysis has been applied to cold plasmas of cesium and potas-
sium, but it is also applicable to hotter and denser plasmas with properly
modified boundary conditions and with radiative heat transmission taken
into account. The authors thank A. N. DREMIN, S. I. KHUDYAYEV, and
A. M. STOLIN for the helpful discussions. The article was presented by
academician N. N. YANENKO on 16 Jul 79. Tables 1; references 4 Russian.
[151-2415]

EXPERIMENTAL STUDY OF SPATIAL MONOCHROMATISM OF UNDULATOR RADIATION

ALFEROV, D. F., BASHMAKOV, YU. A., academician, and CHERENKOV, P. A.,
Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Undulator radiation was studied in various synchrotrons such
as "Pakhra" and "Sirius". Here are reported the results pertaining to
spatial monochromatism of this radiation. Taking into account the Doppler
effect, a single-valued relation has been found to exist between wave-
length and observation angle. Angular monochromatism has also been
defined theoretically in the dipole approximation. Experiments were

performed using a "plane" magnetic undulator with K = 20 periodicity elements λ_0 = 4 cm long each, placed on the straight segment of the "Pakhra" synchrotron orbit. Radiation at some wavelength λ_g (3850, 4630, 5040 Å) appeared at a corresponding electron energy threshold slightly lower than the theoretical one, owing to the finite undulator length. As the electron energy increases above that threshold, the angular distribution of radiation intensity changes from a bell curve to a flatter one and eventually a dip forms at the center between two conical lobes. The vertex angle of these cones depends on the radiation wavelength. Such distributions were recorded on photographic film with 134 and 158 MeV electron beams and measured by microphotometric scanning both vertically and horizontally. The vertex angle of the radiation cones was also measured as a function of the electron energy at the λ_g = 2850 Å wavelength and found to widen with increasing energy, but to a limited extent because of the granularity of the film emulsion. The authors thank K. A. BELOVINTSEV, YE. G. BESSONOV and V. V. MIKHAYLIN for the interest and the helpful discussions, A. O. KULIKOV and A. A. LERMAN for the help in processing the experimental data, also M. P. KALASHNIKOV for kindly making a Jones microphotometer available. Figures 4; references 9: 8 Russian, 1 Western.
[151-2415]

THRESHOLD-FREE DISSIPATIVE BALLOONING INTERCHANGE MODES

POGUTSE, O. P. and YURCHENKO, E. I., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Progress in the investigation of ballooning interchange modes of a tokamak plasma has shown that the necessary criterion of stability for ideal modes of this kind is more stringent that the Mercier criterion. This is a result of new destabilizing terms associated with shear. Because of this, it was found that the threshold of a dissipative kink mode implied by previous research is greater than the threshold of ideal ballooning interchange modes. The authors resolve this paradox by analyzing dissipative ballooning interchange modes on the basis of equations of single-fluid magnetohydrodynamics with consideration of compressibility. It is shown that such modes have no threshold in the tokamak with respect to pressure gradient, and that they develop with an increment considerably greater than the inverse skin time $\gamma \sim 1/\tau_s (\tau_s/\tau_\theta)^{2/3}$ (τ_s is the skin time, τ_θ is the Alfven time with respect to the field of the current, $\tau_s/\tau_\theta \gg 1$). The authors thank Academician B. B. Kadomtsev for constructive criticism and advice. Figure 1, references 9: 4 Russian, 5 Western.
[153-6610]

THEORY OF THE COMPENSATION OF NONLINEAR DISTORTIONS OF A LIGHT BEAM BY WAVEFRONT REVERSAL

BOL'SHOV, L. A., VLASOV, D. V., DYKHNE, A. M. and STAROSTIN, A. N., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Wavefront reversal with induced scattering is a way of compensating for distortions in heavy-duty laser amplifiers as well as in turbulent atmospheres, and of guiding laser radiation onto the target in thermonuclear experiments. These and other applications of wavefront reversal are, however, restricted to linear media, since in nonlinear media powerful beams of light undergo self-stress resulting in their distortion. Thus, in powerful neodymium-doped glass amplifiers used in nuclear fusion the intensity limits hinge precisely on nonlinear phase and amplitude distortions due to small-scale self-focusing. It is shown that such nonlinear distortions can be compensated within the framework of the theory of perturbations, upon linearization of the corresponding equations of beam perturbations. Further, the attendant stabilization of the self-excitation of counter-waves indicates that high reflection coefficients can be attained for waves not entering the aperture of the mirror that reverses the pumping wavefront. Figures 2; references 11: 9 Russian, 2 Western.
[150-1386]

ON THE POSSIBILITY OF COMPLETE COMPENSATION OF NONLINEAR DISTORTIONS OF A LIGHT BEAM BY WAVEFRONT REVERSAL

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[Abstract] The paper gives the results of research first reported at the All-Union Conference Laser Optics 80 in Leningrad 3-7 January 1980. Previous research had shown that under certain conditions of wavefront reversal the Stokes wave accompanying induced Raman scattering distorts the reconstructed image. Therefore experiments were done to differentiate the influence of self-focusing from other factors that distort the wavefront in a Brillouin mirror based on a condensed medium, which generally has cubic nonlinearity. Wavefront reversal was realized by reflection

in CCl_4 with low nonlinearity, and nonlinear distortions were introduced by transmitting the incident and reflected waves through a strongly non-linear substance, CS_2. The experiments were done with reversal of the image of a hexagonal grating with period of 1 mm and transparency of 60%. It is shown that if the reflected wave arises with wavefront reversal, nonlinear distortions can be compensated for any reflectivity of the Brillouin mirror. This principle can be used for complete compensation of nonlinear distortions in a multichannel laser system made up of amplification stages and beam-splitting arrangements. It is shown that reflectivities close to unity can be realized by suppression of self-excitation of opposed waves in non-resonant four-photon wavefront reversal. The authors thank F. V. Bunkin, S. N. Vlasov, G. A. Pasmanik and V. I. Talanov for constructive criticism. Figures 3, references 7: 6 Russian, 1 Western. [154-6610]

OUTLOOK FOR UTILIZING HIGH-TEMPERATURE SUPERCONDUCTIVE NONLINEAR COMPONENTS WITH A-15 LATTICE

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[Abstract] In recent research, the best nonlinear devices based on superconductive weak-links have been produced by using Nb, Pb and Sn. The author considers the feasibility of using superconductive alloys based on Nb and V with A-15 lattice structure for such weak-links, and specifically for frequency multiplication and conversion. Such alloys have high transition temperatures and high upper critical magnetic fields. It is shown that calculations from measurements of specific heat for V_3Si, Nb_3Sn and V_3Ga give severely understated values of the coherence parameter $\xi_0 = h v_F / \pi \Delta_0$, where v_F is the velocity on the Fermi surface, and Δ_0 is the energy gap at $T=0$. Determination of this parameter from optical measurements gives a value of the order of 300-500 $\overset{\circ}{A}$ as compared with the generally accepted value of 50 $\overset{\circ}{A}$ calculated from measurements of specific heat. Thus for a mean free path greater than 500 $\overset{\circ}{A}$ weak-links based on such alloys could operate effectively both at low temperatures and close to the critical point. The author thanks S. I. Vedeneyev for discussing the work. References 9: 7 Russian, 2 Western.
[156-6610]

QUANTUM-MECHANICAL TREATMENT OF THE PROBLEM OF MAGNETIC RESONANCE

DZHRBASHYAN, V. A.

[Abstract] Magnetic resonance is described here in terms of the quantum-mechanical theory of transitions, which takes into account the width of a level and thus dispenses with supplementary concepts of classical physics. The problem is reduced to determining the probability of transition during absorption or emission of a magnetic dipole quantum in a radio-frequency field. Interaction of an atom with those surrounding it broadens the resonance line. This analysis reveals that the absorbed power depends resonantly on the frequency and monotonically, from zero to saturation, on the intensity (amplitude) of the rotating magnetic field. The expression for the absorbed power can be simplified by averaging over Larmor frequencies and assuming a Gaussian distribution function. The author thanks G. M. GARIBYAN and E. G. SHAROYAN for the helpful discussion. The article was presented by academician V. A. AMBARTSUMYAN on 13 Nov 79. References 6: 4 Russian, 2 Western.
[147-2415]

QUANTUM THEORY OF CYCLOTRON RESONANCE WITH RESPECT TO SLIDING ORBITS IN THE NEIGHBORHOOD OF THE FREQUENCIES OF TRANSITIONS BETWEEN SURFACE ELECTRON LEVELS AND DEGENERATE ELECTRON FLUID

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[Abstract] A quantum theory of cyclotron resonance is formulated by using the quantum kinetic equation of small deviations of the density matrix from the equilibrium Fermi distribution in order to describe weakly excited states of the electron fluid. In this connection the Fermi-liquid interaction approximation with the aid of a constant is used here for this purpose. The developed quantum theory of cyclotron resonance on sliding electrons is used to interpret the known experimental findings on the irradiation of bismuth specimens in the infrared range. In that context, the excitation of resonances corresponds to the excitation of surface cyclotron waves. Comparison of experimental data with the developed theory serves to determine the sum of constants of Fermi-liquid interaction

of electrons in bismuth, demonstrates the validity of that theory, and shows that, since the theory applies to the electron fluid of metals with any Fermi surface, it can be used to determine the parameters of Fermi-liquid interaction in metals other than bismuth. Figure 1; references 10: 5 Russian, 5 Western.
[62-1386]

PHENOMENOLOGICAL THEORY OF SPIN COMBUSTION

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[Abstract] During burning of condensed fuel systems with solid combustion
products the zone of exothermic reaction propagates in nonsteady self-
oscillatory and spin modes. Here these spatial transient processes are
described phenomenologically, by the equation of motion for a plane
reaction front which takes into account the advent of a limiting oscillation
cycle and the existence of heat conducting links between plane front
elements. Appropriate corrections are added for a curving reaction front.
The solution indicates phase waves but no amplitude waves on a closed sur-
face such as that of a cylinder base, formation of reaction foci, and
successive appearance of longer-wave spin modes (stable against small
perturbations of the traveling wave) as the cylinder circumference is
doubled, tripled, etc. This phenomenological analysis applies to a body
where vibrational instability of individual elements is associated with
the existence of a correlational dimension as, for instance, charges of
gun powder or other explosives. Figures 1; references 13 Russian.
[151-2415]

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